SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. Show that the potential due to an arbitrary charge distribution at a large distance can be always expressed as a sum of multipole potentials.

17. Derive Ampere's law in differential form and integral form hence obtain expression for magnetic field

   (a) due to a long straight current carrying conductor

   (b) outside and inside a long solenoid.

18. Deduce Maxwell's equation of electromagnetic field and explain their physical significance.

19. Obtain an expression for the electric and magnetic fields produced by an oscillating electric dipole.

20. Write down the Maxwell's electromagnetic equation for free space and obtain their plane wave solution. And hence show that the electromagnetic energy in free space is transmitted in the direction of wave propagation at speed of light.

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APRIL/MAY 2024

DPH22/GPH22 — ELECTROMAGNETIC THEORY

Time : Three hours   Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Write down the Poisson's equation and Laplace equation.

2. Write the expression for electro static energy stored in a dielectric.

3. Define magnetic scalar and vector potentials.

4. Show that magnetic flux in terms of vector potential A is given by $\phi = \oint A \cdot dl$.

5. What is meant by Maxwell's displacement current?

6. Mention the characteristics of electromagnetic potentials.

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7. What is an oscillating dipole? Show that time rate of change of dipole moment of an oscillating dipole is equal to a current element.

8. What is an antenna array?

9. Write down the boundary conditions satisfied by electromagnetic field vectors between parallel and perfectly conducting planes.

10. What is skin depth? Give its expression.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Obtain an expression for the potential inside a dielectric sphere placed in a uniform electric field.

Or

(b) Obtain Gauss law in differential form.

12. (a) Using Biot-Savart law, show that the magnetic field is solenoidal.

Or

(b) Derive expressions for the magnetic scalar potential and magnetic induction due to a circular coil carrying current.

13. (a) Deduce an expression for conservation law for a system of charges.

Or

(b) Establish the fact that Lorentz gauge condition uncouples the inhomogeneous wave equations.

14. (a) Show that the radiation resistance due to a small current element is given by

$$R_r = 80\pi^2 \left(\frac{dl}{\lambda}\right)^2 \; ohms.$$

Or

(b) Derive an expression for the resultant electric intensity due to an array.

15. (a) Show that when electromagnetic waves propagate in a conducting medium the magnetic vector lags behind electric vector.

Or

(b) Show that in a wave guide, TEM waves cannot be propagated along the axis.